HOW TO READ RADIO DIAGRAMS AND SYMBOLS

LESSON NO. ND-5

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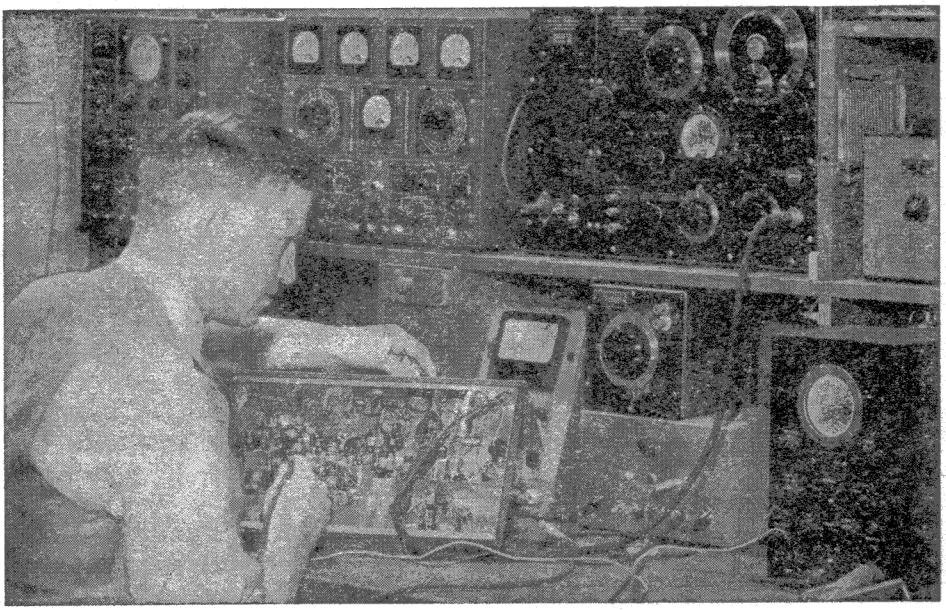

The above photo shows laboratory technician testing radio parts. The various instruments shown are capable of making precise tests on most radio parts.

HOW TO READ RADIO DIAGRAMS AND SYMBOLS

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You have now reached a point in your studies where it becomes necessary for you to learn something of radio diagrams and of the symbols which are used in the diagrams. Radio men have long employed a written sign language. By means of it, it is possible to show every connection in a complicated electrical circuit on a comparatively small area of paper, whereas if a written description were employed it would require several ordinary book-size pages.

A radio diagram is like a chart or graph employed by statisticians, bankers, doctors, etc. It tells much in small space and each and every part may be looked at and studied in relation to every other part.

The system employed is very simple, and once you get fully acquainted with it, you will appreciate its value. You cannot work on radio receivers or study radio literature without having a knowledge of this *short cut* system. Therefore, it is absolutely necessary that you learn it if progress is to be made.

First you should get a clear idea of the component parts of a radio receiver. If you were to analyze a radio set carefully (no matter what kind) you would find that it is nothing more than a number of parts which are electrically joined by means of wires or other types of connectors.

Specifically, the parts used in a radio consist of condensers, (ca-

pacity), coils (inductance), resistors (resistance), vacuum tubes (amplifiers, oscillators, detectors, etc.), switches, metal, etc.

There are hundreds and hundreds of different ways to connect these various parts to *form* different circuits. Obviously, one cannot remember all these things. There is no way of knowing in advance how a radio design-engineer is going to arrange a circuit. Thus it is imperative that a commonly accepted system be employed in order that a radio set manufactured in one part of the country may be efficiently serviced in another part of the country. Over the years an acceptable sign or symbol language has been developed which takes care of this problem nicely.

When you are fully familiar with the symbol system in common use, you can look at a radio circuit diagram and determine almost at a glance just what you want to know.

In explaining how to accomplish this, we must introduce new subjects. However, *just remember that we do not expect you to have a knowledge of everything that is mentioned.* This lesson is intended as a *reference* rather than a lesson which explains fundamental laws. *The various new subjects* which we introduce in this lesson will be explained *in detail in other lessons.* You will have more than one occasion to refer to this lesson as you take up the study of other lessons, so do not hesitate to refer to it whenever you feel the need.

Why Circuit Diagrams Are Used

You will soon see that fundamentally a radio circuit consists of a limited number of parts, connected together by means of wire or mechanical fittings such as screws, nuts, rivets, clamps, etc. Different sizes of these parts or different values may be employed in the same circuit. But, basically, you could count the number of really different parts on the ten fingers of your hands. Thus it can be seen that learning about these parts is not a difficult task at all.

The wiring attached to radio parts actually causes these parts to form several electrical circuits. In this way, current can be forced to flow over selected *paths* (circuits)—thus you can make current influence other adjoining circuits by electromagnetic action and by electrostatic action as you will learn later on.

Each of the different parts which make up a radio receiver exhibits certain characteristics which are called *properties.* As you progress with your studies, you will learn more about these properties. All action or behavior of unit radio parts depends on the way wires are connected to the parts.

To illustrate what is meant by a property, consider wire. Every piece of wire has length. Thus length is a property of wire. A wire when heated is longer than it is at a cold or normal temperature. This, then, is another property of wire—that of expanding when under the influence of heat. Every wire has *resistance,* and this is another property of wire.

A modern radio circuit utilizes many different sizes of parts and a large number of properties are associated with each of these parts.

For instance, there is capacity; inductance, reactance, impedance, conductance, current, voltage, power factor, resistance, etc. Some of these terms or properties are no doubt new to you, but you will, of course, learn more about them in later lessons.

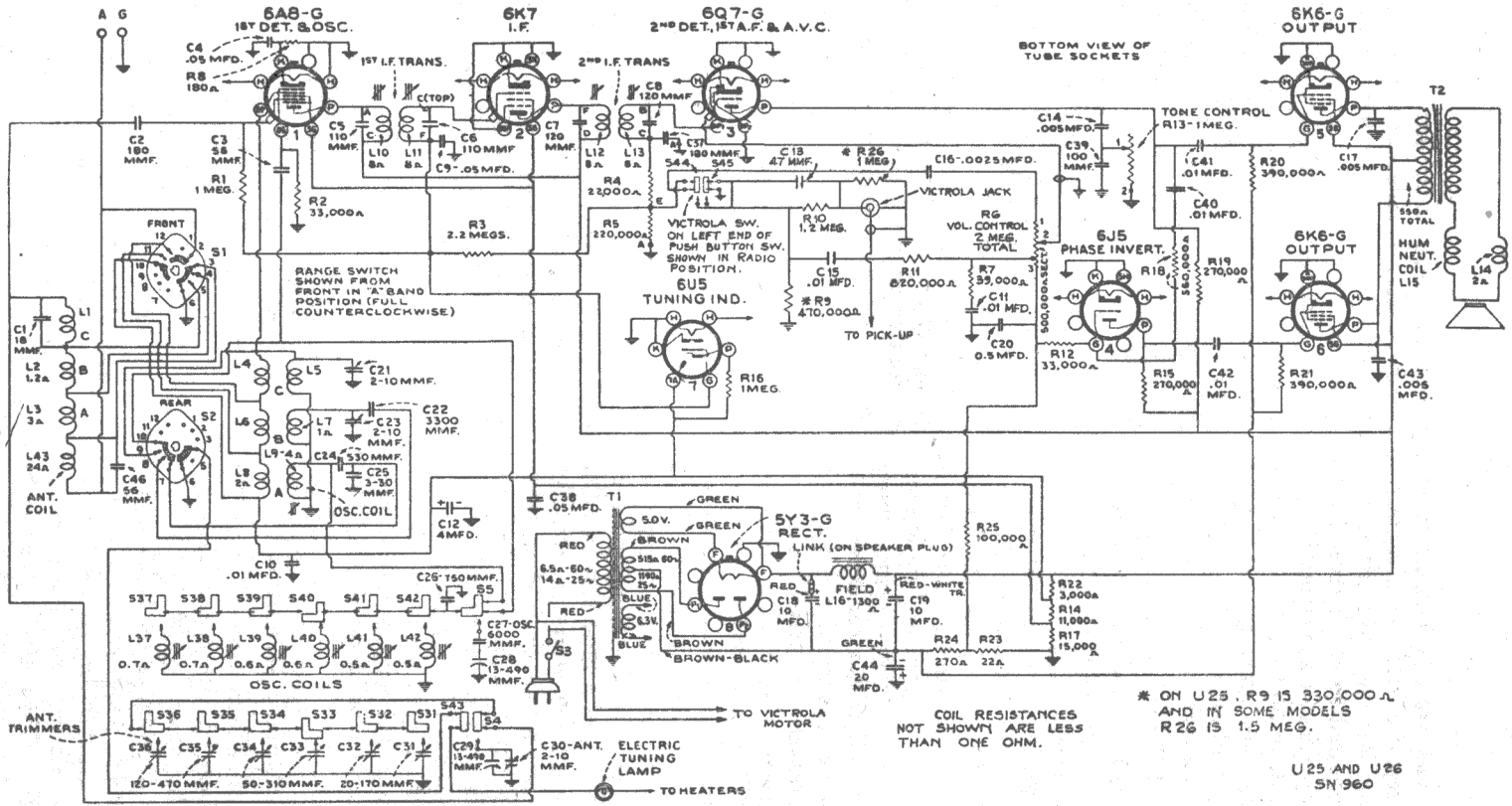

6A8-G
1ST DET. & OSC.
6K7
I.F.
6Q7-G
2ND DET., 1ST A.F. & A.V.C.
6K6-G
OUTPUT
BOTTOM VIEW OF TUBE SOCKETS
TONE CONTROL R13-1 MEG.
VICTROLA JACK
VICTROLA SW. ON LEFT END OF PUSH BUTTON SW. SHOWN IN RADIO POSITION.
RANGE SWITCH SHOWN FROM FRONT IN "A" BAND POSITION (FULL COUNTERCLOCKWISE)
6U5
TUNING IND.
6J5
PHASE INVERT.
6K6-G
OUTPUT
5Y3-G
RECT.
TO PICK-UP
TO VICTROLA MOTOR
TO HEATERS
OSC. COILS
ANT. TRIMMERS
ELECTRIC TUNING LAMP
HUM NEUT. COIL L15
FIELD L16-1300Ω
LINK (ON SPEAKER PLUG)
COIL RESISTANCES NOT SHOWN ARE LESS THAN ONE OHM.
* ON U25, R9 IS 330,000Ω AND IN SOME MODELS R26 IS 1.5 MEG.
U25 AND U26
SN 960

FIG. 1

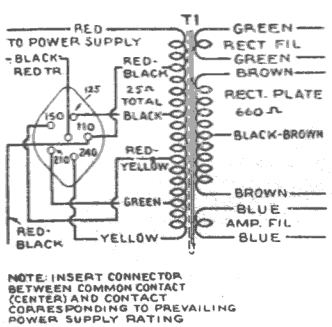
When you are called upon to locate and repair a defect in a radio receiver, amplifier or transmitter, you will be required to check several different properties in a systematic way. It is difficult to do this in a confusion of wiring on any actual circuit. However, with the aid of a wiring diagram, you can check off each circuit as you test it.

Before you can check the properties of the parts used in a radio set, you must know what kind of a part is being used and where the part is located. Simply looking at the assembly inside the set will not always inform you of the kind of part that is used. Even an experienced radio man may have trouble in distinguishing between a coil and a condenser or a resistor when it is sealed inside a container, because in many instances their outward appearances may be similar. This is especially true where the windings of a power transformer are sealed inside a container resembling the one which is used for housing the coils of a filter choke, or the condensers of a filter system. For this reason it is necessary to refer to a wiring diagram to indicate, first, what parts are being used and, second, how these parts are connected. Then you can start at some point which you can readily identify and in this manner trace the wiring, which leads to the actual parts located inside the receiver.

Schematic Diagrams

The radio man almost invariably works from a *schematic diagram.* Such a diagram is shown in Fig. 1. This is a diagram of the RCA set for RCA models U25 and U26. The chassis (actual radio set less cabinet features) number for these sets is RC-386B. Thus the set may be identified under any one of these numbers. Every radio set should include such a number or name under which it may be identified. This should not be confused with the serial number (the number which enables the manufacturer to determine when the set was made and what parts were used in it) because the serial number has no significance unless the model number is also known. Often the radio manufacturer will make changes in a given model. He keeps a record of such changes and records the serial numbers to which these changes apply. In this way radio service men can take note of such changes years after the sets have been manufactured by the simple expedient of referring to manufacturer's literature.

This brings up the matter of how the radio service man obtains his schematic diagrams. Thousands of radio sets have been made in the past and diagrams are available for most of them. *On the other hand, there are some radio sets in use for which there are no diagrams available from any source.* In cases of this kind the service man must rely on his general knowledge of radio sets and trace out the circuits to the best of his ability.



"Showing power transformer connections of Fig. 2."

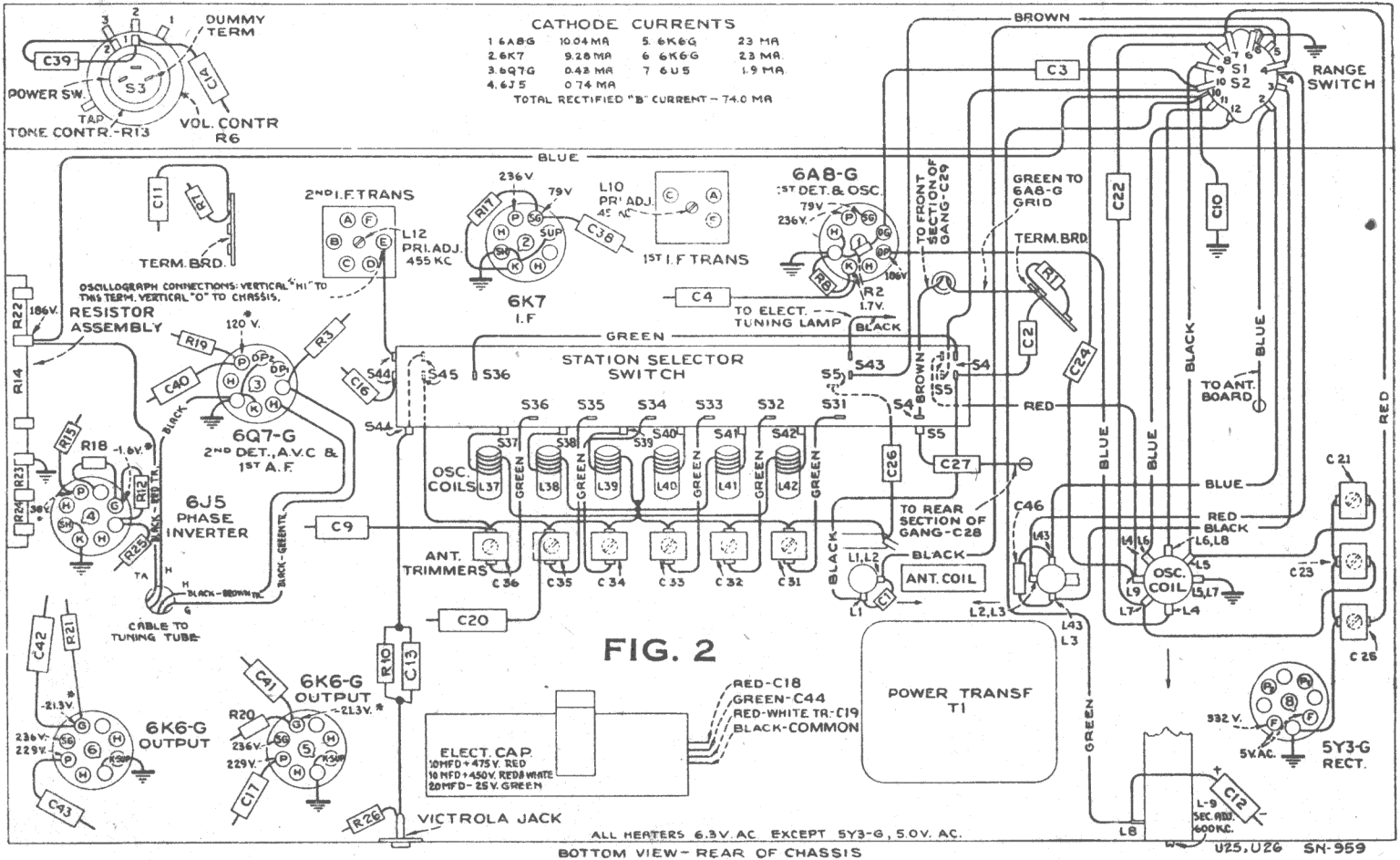

CATHODE CURRENTS
1 6A8G 10.04 MA 5 6K6G 23 MA
2 6K7 9.28 MA 6 6K6G 23 MA
3 6Q7G 0.43 MA 7 6U5 1.9 MA
4 6J5 0.74 MA
TOTAL RECTIFIED "B" CURRENT – 74.0 MA
DUMMY TERM
C39
C14
POWER SW.
S3
TAP
TONE CONTR.-R13
VOL. CONTR R6
BROWN
C3
S1
S2
RANGE SWITCH
BLUE
2ND I.F. TRANS
L12 PRI. ADJ. 455 KC
TERM. BRD.
236V
79V
R17
C38
6K7 I.F
L10 PRI. ADJ.
1ST I.F. TRANS
6A8-G
1ST DET. & OSC.
TO FRONT SECTION OF GANG-C29
GREEN TO 6A8-G GRID
TERM. BRD.
R1
C22
C10
C4
TO ELECT. TUNING LAMP
R2 1.7V.
BLACK
OSCILLOGRAPH CONNECTIONS: VERTICAL "HI" TO THIS TERM. VERTICAL "O" TO CHASSIS.
RESISTOR ASSEMBLY
186V.
R22
R14
120 V.
R19
R3
C40
C16
GREEN
STATION SELECTOR SWITCH
S36 S35 S34 S33 S32 S31
S37 S38 S39 S40 S41 S42
S43 S44 S45
S4 S5
C2
C24
TO ANT. BOARD
RED
BLACK
BLUE
6Q7-G
2ND DET., A.V.C. & 1ST A.F.
R15
R18 -1.6V.*
R23
R24
R12
R25
6J5 PHASE INVERTER
OSC. COILS L37 L38 L39 L40 L41 L42
C26
C27
TO REAR SECTION OF GANG-C28
C46
C21
C23
C26
C9
ANT. TRIMMERS C36 C35 C34 C33 C32 C31
L1,L2
ANT. COIL
L43
L4,L6
L6,L8
L5
L5,L7
L4
OSC. COIL
L7
L9
L2,L3
L3
C1
L1
C20
CABLE TO TUNING TUBE
C42
R21
-21.3V.*
6K6-G OUTPUT
236V.
229V.
C43
C41
R20
C17
R10
C13
R26
VICTROLA JACK
RED-C18
GREEN-C44
RED-WHITE TR-C19
BLACK-COMMON
ELECT. CAP.
10 MFD + 475 V. RED
10 MFD + 450 V. RED & WHITE
20 MFD - 25 V. GREEN
POWER TRANSF T1
332 V.
5V.AC.
5Y3-G RECT.
C12
L-9 SEC. ADJ. 600 KC.
L8
GREEN
ALL HEATERS 6.3 V. AC EXCEPT 5Y3-G, 5.0 V. AC.
BOTTOM VIEW – REAR OF CHASSIS
U25, U26 SN-959

FIG. 2

Fortunately there are few cases of this kind.

There are also some few radio sets in use which are known as *orphans*—that is, all identifying marks on the set have been removed. Here again the service man is up against a blank wall as far as a published diagram is concerned. Either he must rely on his general knowledge of radio sets or draw his own diagram by tracing out the actual wiring of the parts—a slow and laborious process. Such sets cost much more to repair because it takes longer to restore them to normal operation. Fortunately such sets are in the minority and therefore are not a big problem in the industry.

A complete file of all published radio diagrams runs into several volumes in loose-leaf manual form. They are available from radio parts jobbers or wholesalers and from the publishers. In large cities, local public libraries keep radio diagrams on file for public reference. Also most radio manufacturers will provide free or will sell at a nominal cost diagrams of all sets which they have manufactured. The service man, in writing to the manufacturer for diagrams should write on his own printed business stationery, which is usually sufficient evidence to prove that he is entitled to use the diagrams. This procedure is necessary to protect the manufacturer from having to send out thousands of diagrams for which there is no actual need.

It is perhaps fortunate that radio diagrams are available in manual form because over the years several radio manufacturers have gone out of business. If the diagrams had not been collected and published by private individuals there would be thousands of radio sets for which no diagrams would be available today, and servicing of these sets made more difficult as a result.

Pictorial Diagrams

There is another type of diagram which some radio manufacturers include in their radio service manuals. This is called a *pictorial* diagram and a sample of it is shown in Fig. 2. The pictorial diagram is a great aid in showing the layout of parts and actual wire connections. There is a tendency among beginners in radio to rely on the pictorial rather than the schematic type of diagram. The habit should not be allowed to grow, because pictorial diagrams are not available for all radio sets. You can take in with a glance practically everything you need to know about a radio set from a schematic diagram after you learn to read them—on the other hand much study is required when the pictorial diagram is used alone. The pictorial type of diagram is fine when used in connection with a schematic to show the layout of parts, but should never be used alone unless necessity dictates it. The schematic, on the other hand, can be used alone. Experienced radio men rarely refer to a pictorial diagram. Instead they rely almost entirely on the schematic, and you should develop this technique as early as possible.

Learning to read schematic diagrams is merely a matter of becoming familiar with the limited number of symbols which are used in radio. There are many symbols used, but the main seven are: (1) resistance (both variable and fixed), (2) inductance (coils and transformers of all types), (3) condensers (fixed and variable), (4) vacuum tubes, (5) speakers, (6) switches, and (7) batteries. Thus if you memorize the

symbols for these you will have gained the main background you need for reading schematic diagrams.

Resistors

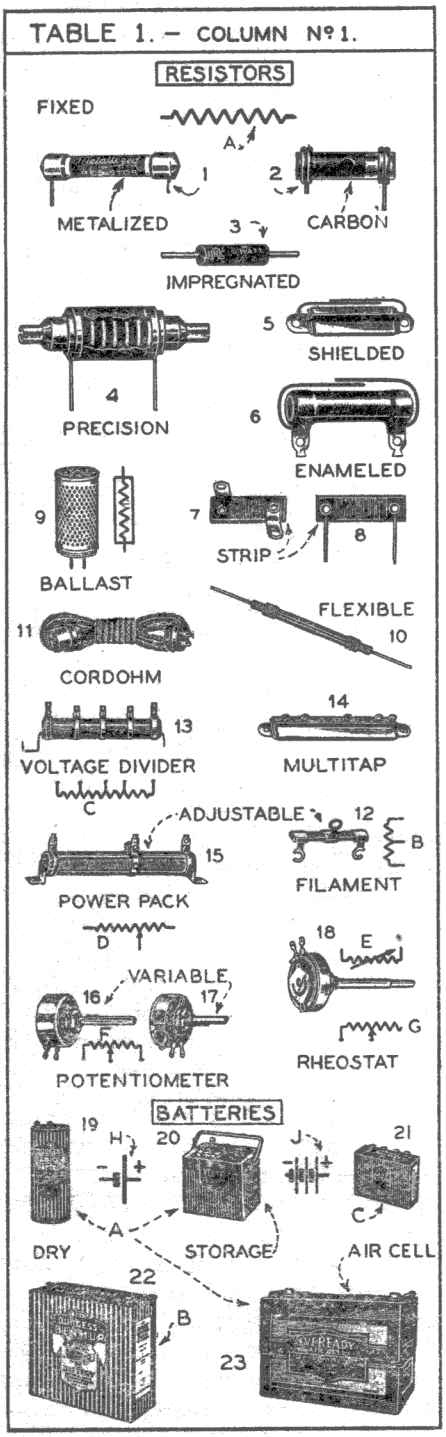
Table No. 1 shows the radio symbols for resistors, batteries, condensers and coils along with drawings of the actual parts. The left column shows the common symbols for resistors and at the bottom of this same column those for batteries are shown. The symbol at the top labeled "A" indicates a *fixed resistor*. Actually it may take the form of any of the resistors numbered from 1 to 11 in this column. Thus, a schematic diagram does not always tell the form or kind of fixed resistor used. All it will indicate is that a fixed resistor is used at a certain point in a circuit. Actually this is all you need to know, because when you get to checking the circuits the resistors will be easily recognized.

Resistors 1, 2 and 3 are low power (½ to 2 watts) fixed resistors of different types. A choice of the type to use lies with the design engineer, and is usually a compromise between cost, size, tolerance of value, temperature coefficient, etc. Resistor 4 is a precision wire wound type used as meter multipliers and in laboratory instruments where close tolerance of values is required. Resistors 5 and 6 are two forms of power wire-wound types, which usually dissipates 5 watts or more. Resistors 7 and 8 are called wire-wound strip resistors. They are usually of the low power type and are often connected across low voltage filament circuits. Sometimes they are used as voltage dividers. Resistor 9 is an enclosed ballast resistor used in some receivers to adjust automatically the power line voltage or maintain it within narrow limits. Often this type of resistor is encased in a glass or metal envelope with base pins, and from outside appearances looks exactly like a radio vacuum tube. The form shown in column 1 of table I is enclosed within a perforated metal container.

Resistor 10 is of the flexible type and may be bent to fit a given space; this is not possible with most other types of resistors. All the resistors from 1 to 8 and 10 have flexible wire leads attached to them, making for easy connection to other parts. These flexible leads are often called *pig-tail* leads—indicating they may be bent in almost any shape that wiring or mounting requires.

Resistor 11 is called a power cord resistor. It is used mostly in small AC-DC sets. It is like the usual power line cord, providing two conductors. One of them, however, is made from alloy resistance wire. Thus, the resistance is spread out over a wide area and does not get excessively hot. The same value of resistor in the form of 5 or 6 would get quite hot (concentrating the heat in a small area) thereby raising the temperature of all the other surrounding parts. By locating the resistance in the line cord, excessive heat is avoided within the receiver cabinet, permitting better operation with less expensive parts.

The next group of resistors, from 12 to 14, are known *as tapped resistors*. Instead of having just two terminals at the ends there are three or more. The letters B and C show symbols for this type of resistor. B is for a three-terminal resistor while C is for the five-terminal type. The symbol for a resistor with more terminals would simply show more



terminals or taps on the symbol, as at C.

Resistor 12 is known as a center tap wire-wound resistor and would ordinarily be connected across a low voltage filament circuit to provide a hum-free connection at the center tap. Resistor 13 is a wire-wound enameled covered type with fixed taps. Resistor 14 is similar to 5 but having more fixed taps. These are wire-wound types with insulating paper or cloth wound around the wire. A metal shell is then clamped around both wire and insulation to hold them in place. C would be the proper symbol for both resistors 13 and 14, as each has 5 taps. Resistors 13 and 14 are also sometimes known as voltage dividers—meaning the distribution of voltage—something you will study in the next lesson.

Resistor 15 is an adjustable resistor having a semi-fixed terminal which can be moved by hand. The symbol for this type of resistor is shown at D, but sometimes the symbol at E is also used. Such a resistor may have one or more adjustable terminals, and the symbol will show this by use of extra taps. Resistor 15 is of the power wire-wound type—a screw at the movable terminal permits moving the terminal along the wire winding to vary the resistance value.

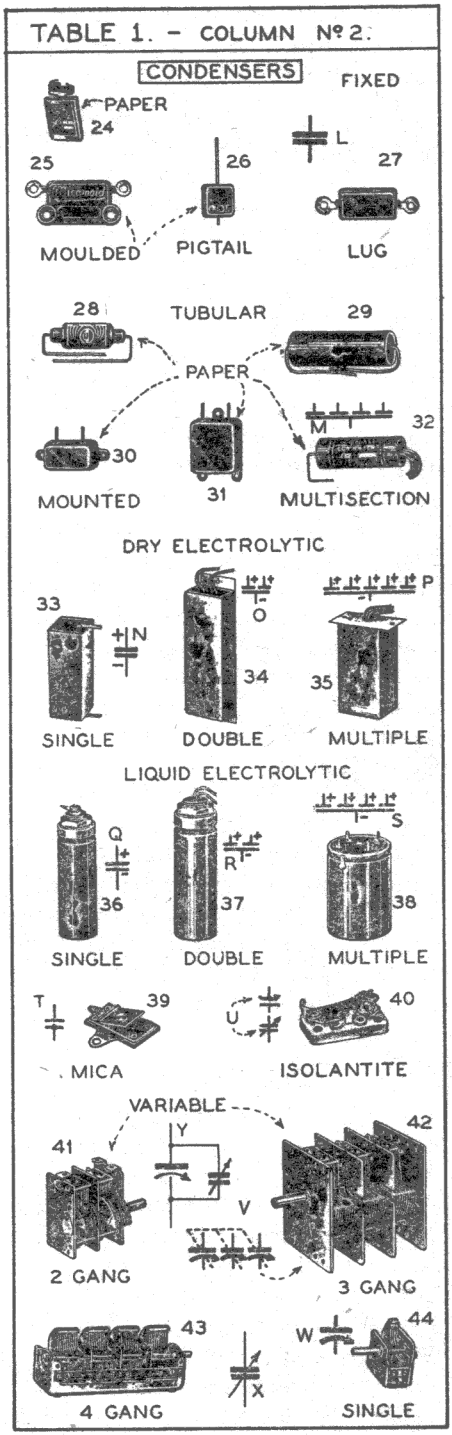
Resistors 16 through 18 are known as *variable resistors,* meaning the resistance value is continuously variable from the lowest to the highest value of the unit. Adjustable and variable resistors are almost alike and frequently no distinction is made between the two types. Thus, the symbol for an adjustable or variable resistor may appear as at D, E, F or G. This is not ordinarily a point of confusion because the symbol indi-

cates a changeable resistance value; examination of the circuit will show the exact form of the resistance. Resistors 16 and 17 are *three terminal* units with one continuously movable terminal. These are known as *potentiometers,* meaning a potential or voltage divider. Symbols F and G are usually used to represent these. Resistor 16 is wire-wound, while 17 is of the disc type with a resistance element sprayed or baked on a disc insulating strip. The metal moving element of the control unit travels over this and so varies the resistance.

Resistor 18 is a *two terminal* resistor similar to 16 and 17. One terminal of this is movable and provides a continuously variable resistance. This type is often called a *rheostat*—the symbol may be either E or G.

Batteries

At the bottom of column 1, table I, several types of batteries are shown. Note that the same type of symbol is used for all of them. The short heavy vertical bar of the symbol is always used for *negative* while the longer and lighter vertical bar denotes *positive.* It is the custom to use one negative and one positive bar for a single dry cell (19). See symbol H. For larger batteries there is no fixed rule as to the number of symbols to use. See symbol J. *There is no relation between the number of battery symbols* and the numerical voltage value of the battery. Thus you should never try to guess the value of the voltage of the battery by the number or length of symbols used. The voltage value is usually indicated alongside the battery symbol on the diagram. The polarity may or may not be indicated along with the symbol. Polarity is usually



easily established mentally from experience and a general knowledge of radio circuits.

Radio batteries are usually classified as "A", "B", and "C". This is a designation which more or less grew up with the industry from the days when all radio sets were battery operated. An "A" battery refers to one used to heat the filaments of vacuum tubes. Its voltage range is from about 1 to 12 volts. It may be a dry cell (19) or a group of them, a storage battery (20) or a special form of battery such as the air cell (23). A "B" battery refers to a large block battery (22) usually of 22.5 volts or more. Its range is usually limited to about 180 volts and a complete "B" battery system circuits of vacuum tubes. A "C" batmay consist of one or more block batteries. Such a battery system is used to operate plate and screen grid vacuum tube. Its voltage range is from about 1.5 to 45 volts. Such a voltage to the control grid of a age type used to apply a negative tery (21) is usually of the low voltbattery has no current flow demand placed upon it and consequently usually has a longer life than A and B batteries. The technical reasons for this will be brought out in other lessons.

Condensers

Column 2 of table I shows *condenser* symbols for different types of condensers. There are two broad classifications of condensers known as *(1) fixed and (2) variable.* This relates to their value. Thus a condenser may have a definite fixed value which is unchangeable. The other type has a changeable value between extreme minimum and maximum values. There are many kinds and types of condensers in these two broad classifications.

In column 2 of table I there is listed, first, several forms of fixed condensers. The symbol for these is shown at L. This same symbol may be used to denote any type of fixed condenser. 25, 26 and 27 of this group are *mica* types of fixed condensers in moulded bakelite form. The word *mica* refers to the type of dielectric between the condenser plates. These are usually used in high frequency circuits where little loss can be tolerated, and have a capacity range from about .1 to .000001 mfd.

The next group of condensers, 28 through 32 are the paper dielectric type. Condenser 24 is also of the paper type with flexible pig-tail leads. These vary in capacity from about .001 to 4 mfd. They are used to filter low frequency circuits and have a tolerance plus or minus of from 5 to 20% of rated value. They may have medium loss qualities and yet perform satisfactorily. Condenser 32 is like the others except that it is of the multiple type and may include 2 or more components. The symbol is shown at M, and for each symbol in the group a separate condenser is indicated.

In the next group, from 33 through 38 the electrolytic dielectric type of condenser is shown. There are two kinds: (1) the dry type and (2) the wet or liquid type. These vary in capacity from about 4 to 100 mfd. They are principally used for A.C. power unit filtering and in circuits where a large capacity in a small space is required. They all have polarity, and their positive and negative terminals must be connected to proper positive and negative points in the circuits in which they are used. The symbols are identical for both

kinds of electrolytics and often the polarity signs are omitted altogether, with the symbol appearing as an ordinary fixed condenser. Note that symbols N and Q are exactly like symbol L except for the polarity signs. Likewise symbols O, P, R and S are similar to symbol M. In each case a separate symbol in a group indicates a separate condenser.

Condensers 39 and 40 are types of adjustable condensers commonly known as trimmer, padder or compensating condensers. They may be indicated as at T or in the form of one of the symbols at U. They range in value from about 3 to 1800 mmfd. Such condensers are usually connected in *parallel* to larger variable tuning condensers and often in *series* with oscillator circuits. This is the type of condenser that is adjusted when tuned circuits are to be aligned.

The final group of condensers is composed of the variable types; those you turn when you tune a radio set from one station to another. Such condensers may be used singly or in groups and controlled from a common shaft. The symbol for these is shown at V and W. The lower portions of the symbol (curved arrow) may not always appear in this form. Often it appears as at X, with an arrow through both parts of the symbol. When the curved arrow is used it usually denotes that the rotor plates are movable. These condensers have a capacity value of from 3 mmfd. to 15 mmfd. for the minimum range and increase on up from 150 mmfd. to 450 mmfd. for the maximum range. These are extreme values for the lower and upper ranges, per section, of each gang. Thus, every variable condenser has an extreme minimum value as well as an extreme maximum value. Few single-section variable condensers are used in modern radio sets. Most of them are of the two and three gang types, as at 41 and 42. Some few four gangs are used, as at 43. Note that in the gang symbol at V dotted lines are used, indicating that the three condensers are all controlled from one common shaft. The condenser symbols of a gang are not always so near each other as at V. Often they are widely separated on a diagram, with dotted lines connecting them and sometimes even the dotted lines are omitted. Most gang condensers have small trimmer condensers (such as the one at 39) mounted on them and connected in parallel to the larger variable condenser. The symbol for this arrangement appears as at Y.

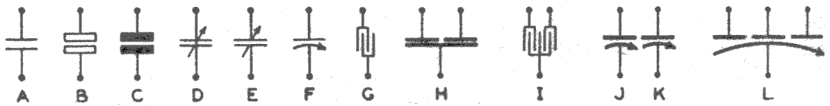
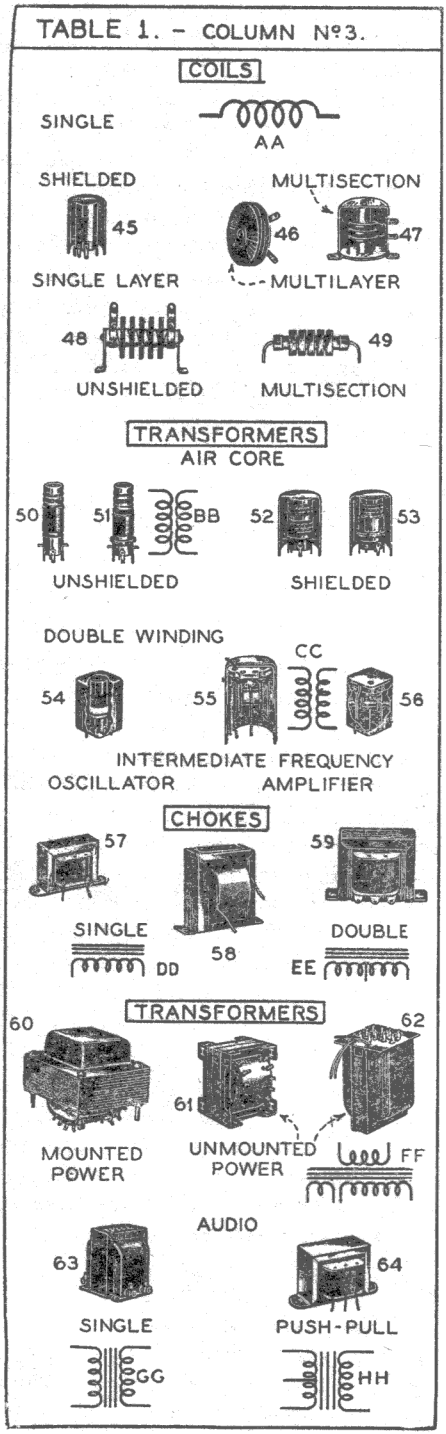


FIG. 3.

Figure 3 shows other samples of condenser symbols. Symbols A, B, C, G, H and I are for fixed condensers. Symbols D, E, F, J and K show different symbols in common use for variable condensers.

Coils

The third column in table I shows symbols for different types of coils, which, as you probably know, are made up of turns of wire on many



types of winding forms. The basic coil or inductance symbol is shown at AA. Regardless of the actual shape of the coil the symbol for it will be some variation of this basic symbol. Coils 45 and 47 are typical tuned coils. They are shielded and are of the air core type. They are tuned with variable condensers. Coil 46 could be either an R.F. choke coil or a multilayer tuned coil. 48 and 49 are typical pie wound R.F. choke coils.

Where two coils are shown as for the symbol at BB they classified as an R.F. transformer, meaning Radio Frequency Transformer. Coils 50 through 56 are typical examples. These all have two or more windings and are usually tuned with condensers. Such coils are used in radio frequency, oscillator and intermediate frequency stages of a radio set. Usually a condenser symbol of one kind or another is shown connected across the coil windings, indicating that the coils are tuned. Note that the symbols BB and CC are exactly alike even though different types of coils are referred to. This is common practice and the radio man soon learns what type of coil is specified because he knows what types of coils are used in certain stages of radio sets.

The symbol for a coil does not intend to show how many turns of wire are used. Neither does it intend to show the direction of winding. For instance, when a wiring diagram like Fig. 1 shows one coil apparently wound in one direction and another coil apparently wound in the opposite direction, like L4-L5, L6-L7, L8-L9, etc., this does not indicate that the two coils are actually wound opposite to each other. Each symbol just means that a coil is being used.

The draftsman who made the symbols simply found it easier to show them in that manner because the diagram would be neater.

Frequently two coils or more are wound on top of each other, or one coil is placed end to end with another, or probably one coil will be placed inside of another, such as is found in actual practice in a tuned RF or IF transformer. In such cases, two separate symbols for coils are drawn fairly close to each other as for L12-L13 in Fig. 1. The symbol merely indicates that you will find the two coils very closely arranged to each other. If the two coils are placed in a metal shield or cover, this is sometimes indicated by enclosing those symbols with a dotted line. However, many wiring diagrams do not show these shields, even when they are actually used.

The next group of coils, 57 through 64, are of the iron core type. Coils 57 and 58 are known as iron core A.F. chokes and DD is the symbol. Such coils are usually used in the power units of radio sets to aid in the filtering or reduction of hum. Coil 59 is similar to 57 and 58 except it has three connections. The symbol is at EE. Such a choke might be used in the power unit or it may be used as a push-pull input or output transformer.

Transformers

Coils 60 through 62 are more properly known as *power transformers.* The symbol is shown at FF. These transformers have a primary winding, a high voltage secondary winding and one or more low voltage secondary windings. The single winding above the straight horizontal lines (these indicate an iron core is used) refers to the primary. The

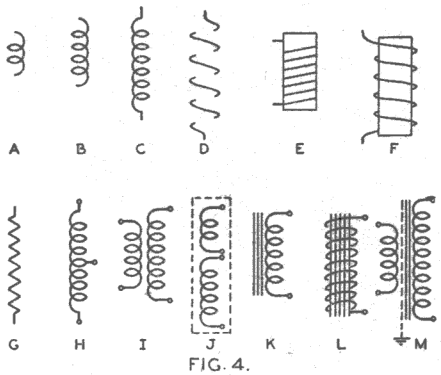


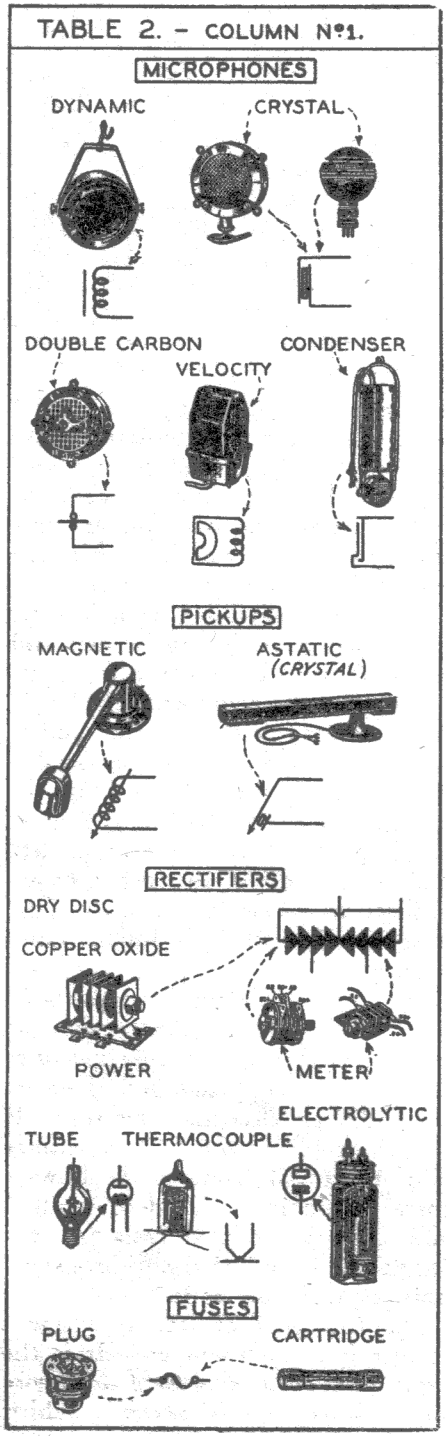
FIG. 4.

two windings below the horizontal lines refer to the secondaries. Remember, on the secondary side several different windings may be shown. Too, the transformer symbol may be drawn in either the horizontal or vertical position.

The two remaining transformers are known as A.F. transformers and they are used to couple A.F. stages of amplification together. The single type is shown at 63 and the symbol at GG. A push-pull transformer for two tubes is shown at 64 with the symbol at HH. If the tapped (center connection) side is shown to the left it is usually called an output transformer and if it is shown to the right it is usually called an input transformer.

Figure 4 shows more coil symbols. A, B and C are alike except for length. Symbols D and G are now obsolete but you may find them in old radio or electrical literature. E and F are forms you will sometimes find in pictorial diagrams. H shows a three terminal coil winding while I and J show coupled coils in two forms. K, L and M show three symbols for iron core coils.

Another type of iron core transformer is in common use. It is the *high frequency powdered iron-core type.* The core is *variable* which



helps to tune the coil to a given frequency. The symbol of this type of coil is shown at L37 through L42 in Fig. 1. The arrow through the straight lines of the core indicates that the core is variable, or changeable in value. Another symbol for the same type of coil is shown in Fig. 1 at L10, L11, L12 and L13.

After studying this explanation you should be able to identify all the various coils shown in Fig. 1 and Fig. 2. Look over these figures and see how many coils you *can* identify. Study the coil symbols given in the table because these give the key to all the coils shown in Fig. 1.

Microphones, Rectifiers, Fuses, Antennas, Speakers.

In table 2 another group of radio symbols is shown. In column 1 are shown several microphones. These are identified by arrows. All types are in use, and you will see the symbols in connection with public address, transmitter, and receiver diagrams. Below the microphones are shown phonograph pick-up units. Note that symbols are similar for both the magnetic and crystal types.

There are many types of rectifiers used in radio work, but the most common are the vacuum tube and dry disc types. These are used to change A.C. to D.C., as you will learn later on in other lessons. The thermocouple types are used in special applications where small currents are to be rectified. The electrolytic type is now obsolete and not used very much any more in radio work. Refer to column 1 of table 2 for drawings and symbols for the various rectifier types.

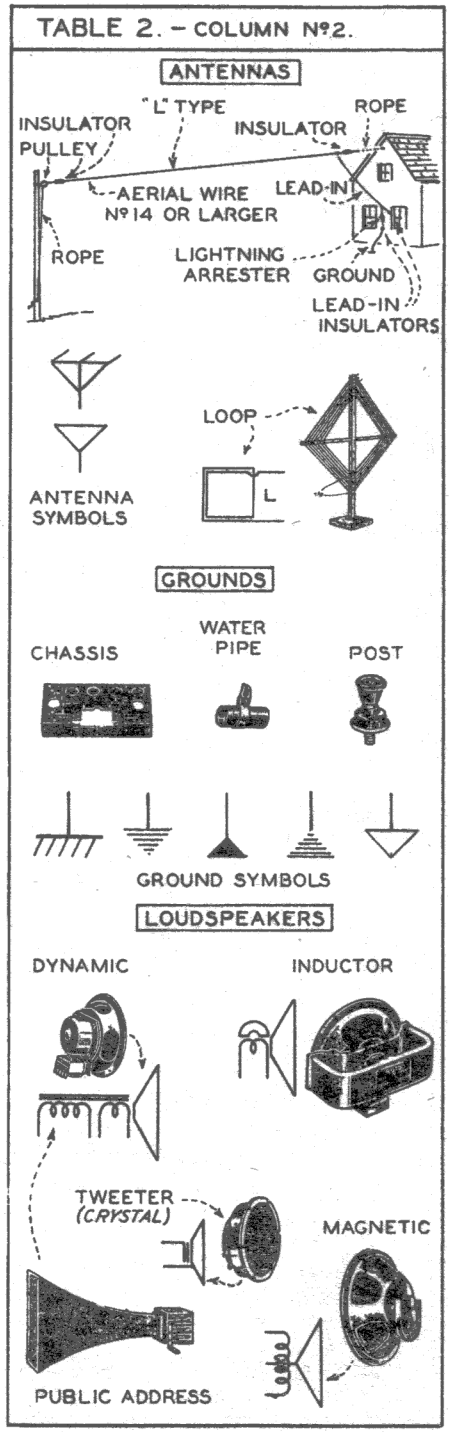
The two remaining items in column 1 of table 2 are fuses. The plug type is used in some heavy power installations but the cartridge type is more common in radio work.

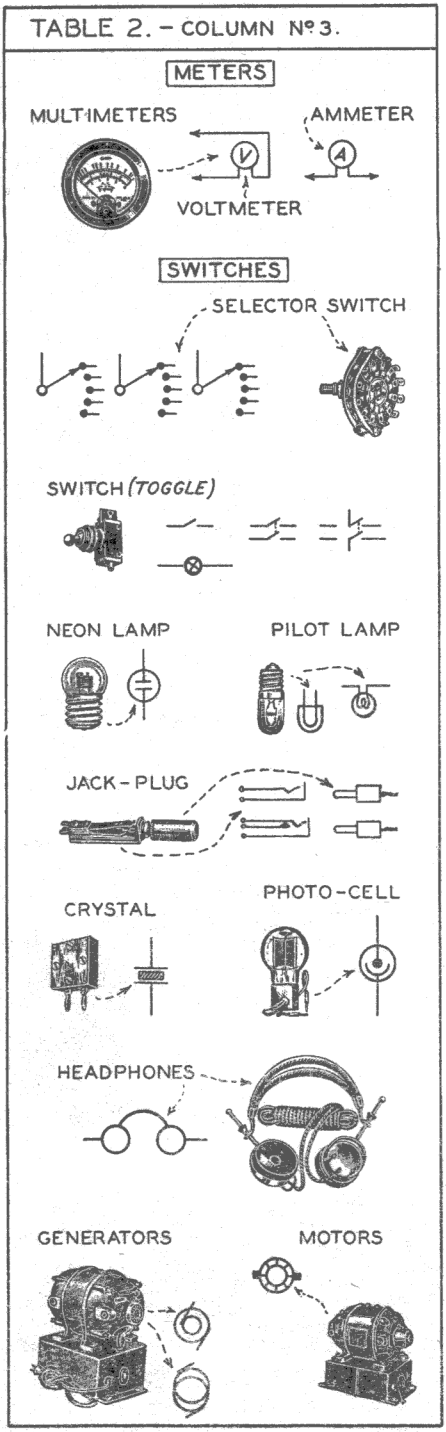
At the top of column 2 of table 2 you will find a drawing of an antenna system. The antenna or aerial symbol is shown just beneath the drawing. The loop and its symbol are shown to the right of the antenna symbol. Loops take the place of antennas and are used extensively in small radio sets. The modern trend is to attach a large coil of wire to the receiver chassis or cabinet. Loop symbols vary but they all take the general form shown in table 2. Next, in column 2 several ground symbols are shown. The symbol itself may refer to an actual ground connection, such as a rod driven into the soil, a water pipe, a connection to a metal chassis, or to a specified point such as a binding post or ground lead. With a little experience you will soon learn the exact type of connection indicated.

Next, in this column is shown speaker symbols. Speakers in most common use are the dynamic, inductor dynamic (one without an electromagnet), magnetic or permanent magnet. Their symbols are easily recognized by the shape of the cone part of the symbol—as, for example, the speaker symbol in Fig. 1. The public address speaker in table 2 is often called an expotential horn and usually employs a dynamic or permanent magnetic speaker unit.

The symbols for radio measuring meters are shown at the top of column 3 of table 2. The meter shown is of the multi-range type and either a voltmeter or a milliammeter symbol may be used to symbolize it.

In the switch group of symbols, the selector type is shown first. Such a switch may have almost any number of contacts and several of them may be joined together to form multiple deck switches. Many such switches





are used to change tuning bands in a receiver and may possibly have five or six decks. Symbols for multiple deck selector switches are not very uniform and there is considerable variation between symbols used by different radio manufacturers. For instance, in Fig. 1 note the appearance of switches S1 and S2. This is a two deck switch, a control rod going through both decks, which turn as the control rod turns (control rod not shown). Note that the contacts of each deck are numbered from 1 through 12 and *some of them are blank* or show no connection. This is because the same switch forms are used for many types of switches regardless of the actual number of contacts needed. *Thus, it is common practice to see many switch contacts not in use.* The shaded portions of switches S1 and S2 of Fig. 1 are the movable parts of the switch. Note that both decks are not alike. S1 has three movable segments while S2 has only two. In visualizing the action of only one deck of a switch you must remember that if one segment moves, all others of the same deck must also move. Thus, if you imagine that the left hand segment of S1 moves one position in a clockwise direction, then the center and right hand segments will move the same amount, and in the same direction. This movement may be traced from a diagram. The left segment will move from contact 10 to 11. The center segment will move from 2 to 3, the right segment will move from 3 to 4 and contact 6 will continue to be grounding the right-hand segment. This is indicated by the arrow from contact 6, which shows that as rotation of the switch is continued contact 6 will remain connected to the right segment be-

cause of its length. It is interesting to note that some other radio manufacturer may indicate the same type of switch in a slightly different form, yet when the circuit is traced you will find it to be electrically correct. Later on in your training you will get detailed information on how to trace switch circuits.

To return to column 3 of table 2 the switch shown below the selector switch is known as the toggle type. A switch of this type is usually used to turn the radio set on and off. Such a switch may be of the single or double pole type. The symbol to the right of the toggle switch is usually used for a single pole type, the other two on the right are for double pole switches.

Lamps, Jacks and Plugs

Lamp symbols are shown below the switch symbols. The one on the left is of the neon type (having two electrodes) and two symbols are shown at the right for pilot lamps—the type usually used to light up the tuning dial.

Below the lamps you will find symbols for jacks and plugs. A jack is a device usually permanently wired to a circuit into which a plug with wire leads may be inserted. This permits the extension of the circuit connecting to the jack. For instance, two wires may be attached to the plug which may in turn be connected to a meter or to headphones, depending on the purpose of the circuit in question.

Just below the jack and plug symbols are shown types of crystals and photocells along with their symbols. A crystal is used for frequency control in transmitters and receivers. The photocell is used to change variations of light into equivalent electrical variations. These things will be taken up in detail at the proper point in your studies.

Generators, Switches Electron (vacuum) Tubes

Generators and motors are both used in radio. These are shown at the bottom of column 3 of table 2. In the case of phonograph motors the symbols may not be used at all—often one or more iron-core coils are shown instead, straight heavy lines being used to indicate the core as in the case of an A.F. transformer.

Next consider some of the vacuum tube symbols. Do not become confused about some of the terms which are mentioned—a full explanation of these will be given in your lessons on vacuum tubes.

There are many kinds of radio tubes in use and to attempt to list all of them in this lesson would require considerable space and would involve a special study of tubes—a subject which will be taken up later in your training. The particular point of this lesson is symbols, and from this viewpoint it is possible to show most of the tube types. Manufacturers of radio sets have not all adopted a standard method of drawing tubes, but all systems are so nearly alike that it is not possible to mistake a tube for some other radio part, even

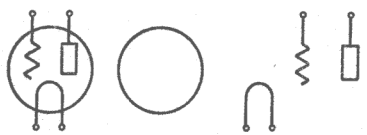


FIG. 5.

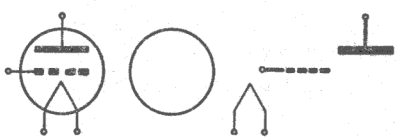
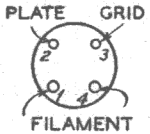


FIG. 6



BOTTOM VIEW OF SOCKET CONNECTION

FIG. 7.

BOTTOM OF SOCKET

FIG. 8.

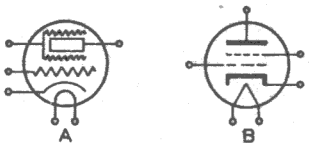


FIG. 9

though there are minor variations in drawing the symbols. Most of the manufacturers have adopted a system similar to that shown in Fig. 1, wherein the tube elements are shown enclosed within a large circle. This circle is supposed to represent the envelope of the tube whether it be glass or metal. The smaller circles outside of the larger circle represent the pins on the base of the tubes. They are usually lettered to identify the element to which they connect within the tube. These pins are also numbered according to standards adopted by the Radio Manufacturers Association. Your tube lessons will describe this system in detail.

To return to the tube symbols in Fig. 1—the various letters used to identify the tube elements have the following meaning: DP1—diode plate No. 1, DP2—diode plate No. 2, H—heater or filament, K—cathode, KSUP — cathode-suppressor, OG—oscillator grid, OP—oscillator plate, P—plate, P1—plate No. 1, P2—plate No. 2, SG—screen grid, SH—shield, SUP—suppressor grid, and TA—target plate. This by no means is a complete list.

The circle representing the metal or glass envelope is not always shown around the tube elements on a wiring diagram. Many times it is omitted for it is generally understood that an envelope surrounds the tube elements.

One type of vacuum tube (a triode) uses a single filament, grid and plate. These are called *elements* of a vacuum tube and are always enclosed in a glass or metal envelope. A tube such as that just described is shown in Fig. 5A. B represents the glass or metal envelope.

C represents the filament (sometimes called the heater) through which current is passed for the purpose of generating heat. Notice that this filament or heater provides *two connecting terminals.* D represents the grid, generally called the *control grid,* while E represents the plate. Each of these is provided with only a single connecting terminal which in actual practice generally leads to an individual pin at the base of the tube.

Fig. 6 shows another symbol for the same type of tube represented in Fig. 5. The complete symbol is shown in Fig. 6A. The envelope or container is shown at B, the filament is shown at C, D represents the control grid and the plate is represented at E.

You must bear in mind that a wiring diagram uses symbols, and these do not always show the location of the pins and the location of the actual parts which are connected to the pins. The information which shows where and how the tube pins are located for all types of tubes is usually to be found in detail form in tube manufacturers' technical literature.

For instance, a schematic diagram may use the symbol shown in Fig.

5A or Fig. 6A; the symbol would be marked with letters and numbers to show that this represented a type 2A3 tube. Reference to a manufacturers tube manual would show that the socket for this 2A3 type tube would be arranged as shown in Fig. 7, where pins No. 1 and No. 4 connect to the filament, while pin No. 2 connects to the plate and pin No. 3 connects to the grid.

Frequently the manufacturer combines the actual sketch of the location of the tube pins with the symbol on the diagram. For instance, the symbol in Fig. 6A is often combined with Fig. 7, and the whole would appear in the form shown in Fig. 8. Note that Fig. 1 uses a system similar to this.

Figure 9 represents another type of vacuum tube with two additional elements. The symbols for the heater, control grid, plate and envelope can be readily recognized from your knowledge of Figs. 5 & 6. The extra symbol nearest the plate in Fig. 9 represents another grid which is called the *screen grid* and is used as an aid to get better performance from the tube. The extra symbol nearest the heater represents the *cathode* which, when heated by the heater, will throw off electrons. In Figs. 5A and 6A the heater itself acts as a cathode for throwing off the electrons and for this reason its construction is simpler.

Other types of vacuum tubes may have more grids or plates; some have separate cathodes and some use the filament as the cathode to produce a property in the tube which is desirable, or possibly to suppress a property which is undesirable.

Radio tubes are manufactured to perform a specific job, and although they may have different ratings they may all be classified into distinct types. Thus, you will see listed amplifiers, which include triodes, pentodes, tetrodes, etc. Next there are converters, which include pentagrids, triode-hexodes, triode-heptodes, octodes, etc. In the detector group there are diodes, rectifiers, and diode-amplifiers. The foregoing words ending in *ode* refer to the number of useful elements within the tubes. They are taken from the Latin and the Greek. Diode refers to 2 elements, triode—3, tetrode—4, pentode—5, hexode—6, heptode—7 and octode means 8 elements. These are terms you will not necessarily be required to remember. Then there are oscillators, of which several types may be used. In the rectifier class there are several types known as half and full-wave rectifiers; these may also include an amplifier function within the same tube envelope.

Most present-day tubes have either a metal or glass envelope. Fig. 10 shows a typical example of both

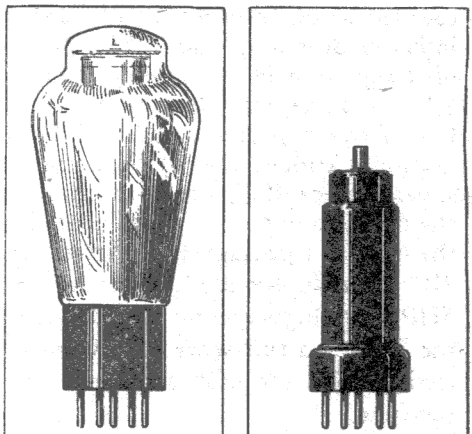


FIG.10.

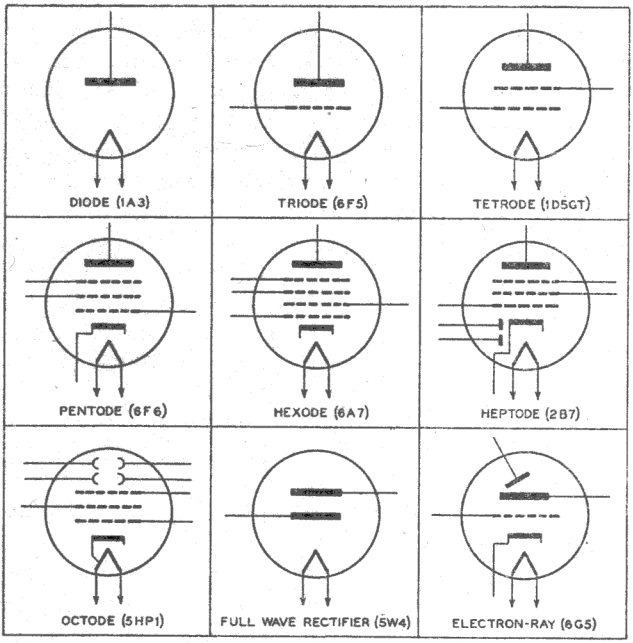


FIG.10.A.

types and in Fig. 10A along with *sample symbols of several tube types.* The symbols are labelled according to the number of useful elements within the tube envelopes (where both cathode and filament are used they are counted as one element—without cathode the filament is counted as one element). The radio industry does not follow this system of designation in every respect. The 1A3 is sometimes referred to as a high frequency diode, the 6F5 as a high-mu triode, the 1D5GT as a super-control R-F amplifier tetrode, the 6F6 as a power amplifier pentode, the 6A7 as a pentagrid converter, the 2B7 as a duplex-diode pentode, the 5HP1 as a high-vacuum cathode-ray, the 5W4 as a full-wave high vacuum rectifier, and the 6G5 as an electron ray tube.

The best way for the practical radio man to keep up to date on tube symbols, names, types, etc., is to purchase annual tube manuals from the tube manufacturers. Such a manual may be obtained for just a few cents. The Sylvania Electric Products, Inc., of Emporium, Penna., call their tube book, "Technical Manual" while the RCA Manufacturing Co. Inc., of Harrison, N. J., call their book "Technical Series RC—". Both manuals are also available from radio parts jobbers and wholesalers.

Tracing a Circuit

It will be of considerable help to be able to trace a circuit of a radio receiver, power unit, amplifier or transmitter at an early stage in your studies. You may not, of course, understand all of the *why* of every circuit, as this will require study and experience. You may, however, notice distinct methods of connecting various parts in a circuit, and when you come to the characteristic operation of the various parts and know their cooperative effect in a circuit, you will better understand the operation as a whole.

For this purpose of tracing a circuit the Philco superheterodyne model 610-B shown in Fig. 11 has been chosen; reference will also be made to the RCA circuit in Fig. 1. These are relative simple circuits, being conventional in every respect. Complete receivers of this type can be considered as a number of separate circuits. Furthermore, the entire circuit may be divided into separate

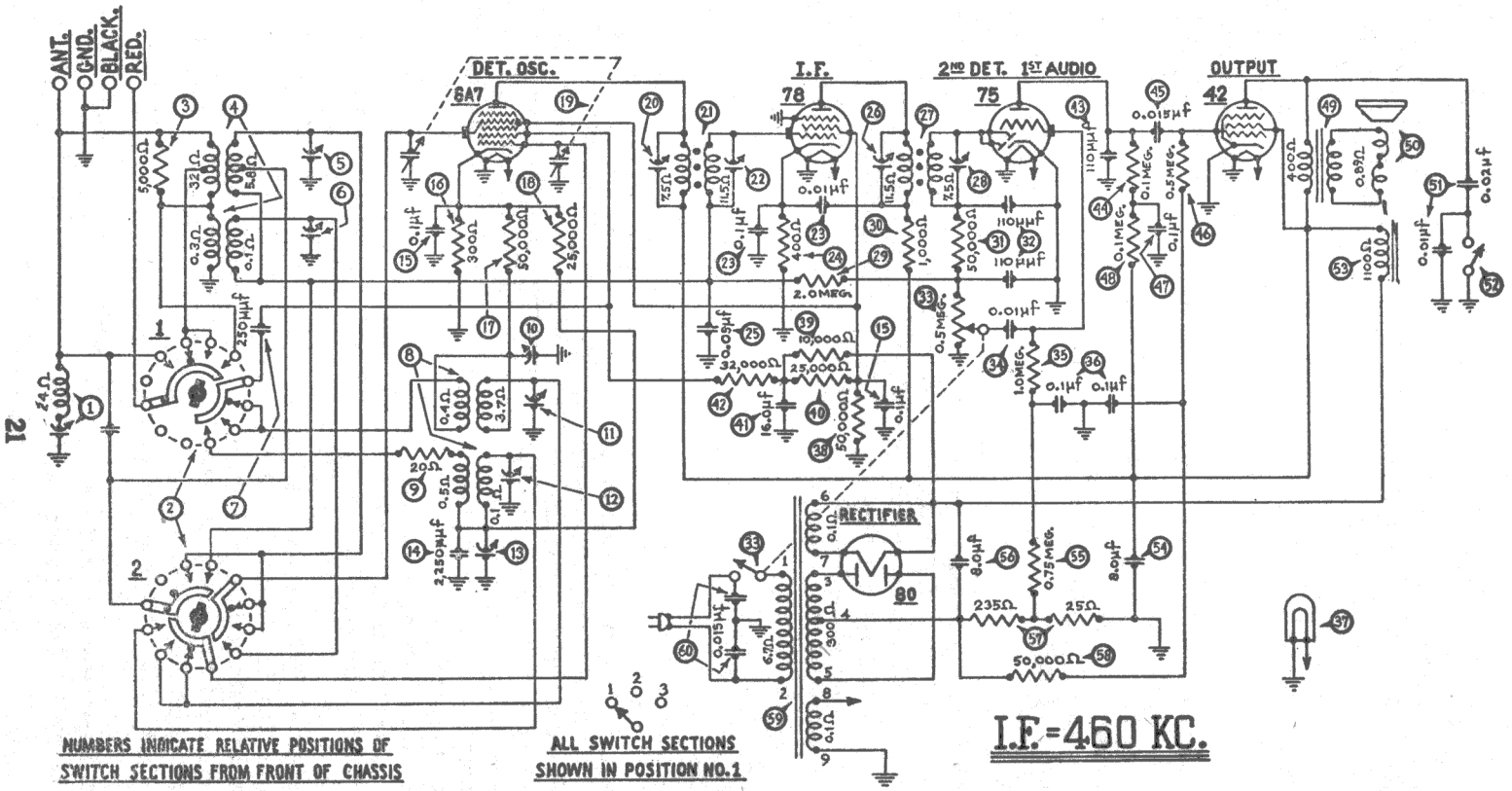

ANT.
GND.
BLACK.
RED.
DET. OSC.
6A7
I.F.
78
2ND DET. 1ST AUDIO
75
OUTPUT
42
RECTIFIER
80
NUMBERS INDICATE RELATIVE POSITIONS OF SWITCH SECTIONS FROM FRONT OF CHASSIS
ALL SWITCH SECTIONS SHOWN IN POSITION NO. 1
I.F.=460 KC.

FIG. 11

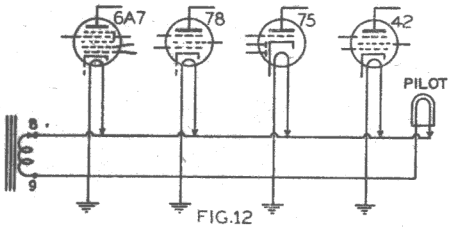


FIG.12

smaller circuits, which allows easier tracing of the wiring.

First the filament circuits will be traced. As a result of your previous study you should be able to identify the filament of each tube in Figs. 1 and 11. Note that in Fig. 11, one filament terminal of each tube is grounded (except the rectifier tube—the one marked 80) and one filament terminal of each tube has an arrowhead. The ground symbol represents the metal chassis of the receiver. This means that one side of the filament circuit is grounded or connected to the metal chassis. *It does not, however, necessarily mean that each tube has one of its filament terminals grounded at the tube socket, nor does it mean that the chassis acts as a part of the filament circuit.* It merely means that at some point along the actual wire circuit one side of the filament circuit is connected to ground or to the receiver chassis.

In radio diagrams you may often have to *visualize a complete circuit when a part of the circuit is shown making use of the metal chassis as a conductor.* To realize the full significance of this, consider the filament circuit of Fig. 11 in careful detail. Note that terminals 8 and 9 of the power transformer (item 59) are arranged similarly—that is, one terminal is grounded (No. 9) and one terminal (No. 8) has an arrowhead.

This simply means that the metal chassis of the receiver is connected to terminal 9 of the power transformer—thus, the filament circuit is grounded to the chassis at this point. Actually, a wire circuit is connected from terminal 9 of the power transformer to each of the filament terminals shown grounded in Fig. 11. Another wire circuit is used to connect terminal 8 of the power transformer to each of the tube filament terminals which have arrowheads.

The reason actual wire connections are not shown in the diagram is that just this many more wire lines would be required in the diagram—a situation likely to cause confusion when tracing the connections of more important parts which have to do with the signal voltage. This is just another example of a shortcut which is often made use of in radio wiring diagrams.

In order that you may clearly understand all of this, the complete and actual *wire* connection for the filament circuit is shown in Fig. 12.

Now refer to Fig. 1. This shows a slightly different method of arranging the filament circuit. At the transformer secondary winding, the filament circuit is identified by the two blue wire leads with arrowheads. Next, note that at the H terminals of each tube socket similar arrowheads are used, indicating a continuation of the filament circuit. Note too that

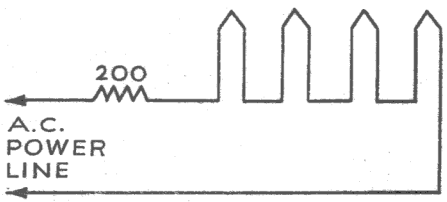


FIG.13

the filament circuit is grounded at the sockets of the 6A8-G and 6U5 tubes. All of this simply means that the filaments of all tubes (except the 5Y3G rectifier) are connected in parallel across the 6.3 volt secondary on the power transformer, even though all of the wiring is not shown. This method of showing the wiring of filament circuits is not usually employed for *series wired filaments*. In this case the complete wiring for the filaments is usually shown as in Fig. 13.

Physical Arrangement of Radio Wiring

There are two general systems of indicating the *actual wiring of radio circuits*. These two systems are illustrated in Figs. 14 and 15. In these two circuits are indicated *wire* connections from the low voltage secondary of a power transformer to the filament contacts on two vacuum tube sockets. The connection to the plate terminal of each tube socket is also shown.

In Fig. 14 note particularly that large dots appear at certain places on the wiring. *This has a particular significance.* It means that an actual wire connection is intended at this point in the circuit. Note where the plate wire crosses the filament wires. There is no large dot at this point—indicating that there is no wire connection at this point.

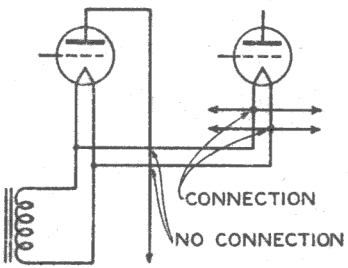


FIG.14.

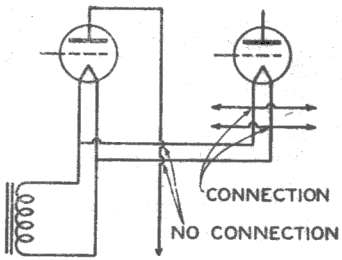


FIG.15.

Figure 15 represents another common method of showing how wires are connected to radio parts. In this system, *half circles* are employed to indicate *no connection*. That is, where two or more wires cross *without* these half circles there is a connection—half circles or loops of course mean *no connection*. Figure 1 of this lesson makes use of the half loop system while Fig. 11 shows the dot system. These two systems should be studied very carefully until you are sure you understand the principles of each, and the difference between the two.

How to Trace the Wiring of Circuits

Referring again to Fig. 11, there are three secondary windings on the power transformer. Two are low voltage filament windings and one is a high voltage winding. One filament winding is for the 80 rectifier type tube with terminals marked 6 and 7. They connect directly to the rectifier filament terminals. Power is provided for the set by the voltage induced in these windings from the varying magnetism in the iron, produced in turn by the A.C. current flow in the primary winding of the power transformer. The same general system is employed for Fig. 1.

Continuing with the analysis of Fig. 11, in order of simplicity, the plate circuits are next. From the

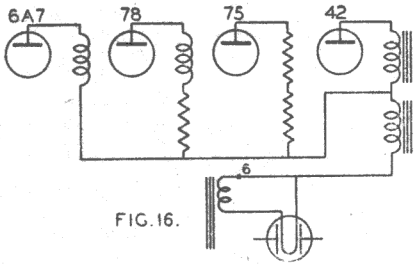


FIG.16.

plate of the first tube from the left, the 6A7 type, follow the wire connection to the plate coil, at each end of which is connected condenser 20. Follow the wire from the lower end of the coil down to the horizontal line. Keep this horizontal line in mind—it is the positive or voltage feeder line. Now start from the plate of the second tube from the left, type 78. Trace the lead from its plate (top element in the circle) through the coil associated with condenser 26 and then through the 1,000 ohm resistor, No. 30, to the horizontal line. Now skip to tube three, a type 75, and from its plate follow the connection, first through the 0.1 meg. resistor (item No. 44) and then through another 0.1 meg. resistor (item No. 48) to the horizontal line. In tracing such circuits, filaments, plate, grid, screen, etc., you may come to a condenser connected in parallel or across another part—just ignore it until later. You are now tracing circuits which carry a continuous flow of electrons (DC), a condenser will not permit DC to flow.

The plate of the output tube also connects to the horizontal voltage feed line through a 400 ohm coil, which is the primary of the transformer marked No. 49. Disregard the connection going back to the output tube, and follow the lead to item 53 (1,100 ohms) down to terminal 6 of the rectifier filament winding. This completes the tracing of all the plate circuits of the receiver. The plate circuits as a separate circuit would appear as in Fig. 16.

Almost without exception, the plate of every tube in a receiver connects through coils, resistors or both to the filament or cathode of the rectifier tube. To complete the tracing of the entire current carrying circuits, you must trace from the negative voltage source to the positive voltage source through the tubes, following the manner in which electrons actually traverse the circuit. The negative voltage source is the center tap of the high voltage winding terminal No. 4 of Fig. 11.

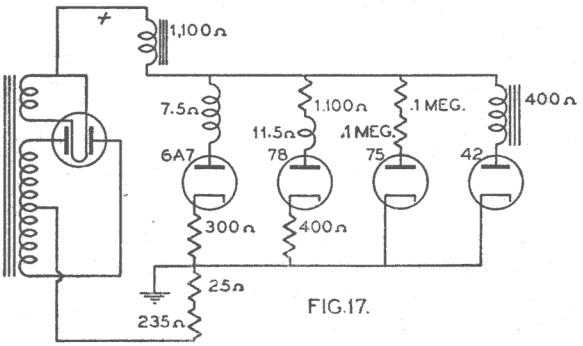


FIG.17.

A complete and simplified picture of the entire plate circuits of all tubes in this receiver is shown in Fig. 17. Note that all of the plate circuits are in parallel. In this diagram the parts are arranged as simply as it is possible to arrange them, and all electrons are moving upward from negative to positive. By considering all of the D.C. current-carrying units as resistors and the voltage source as a battery, the circuit *equivalent* would be as shown in Fig. 18. The total resistance of the complete resistance network may easily be found by cal-

culation, the principles of which will be explained in your next lesson.

Now that you have had some practice in tracing plate circuits, it is suggested that you see how well you can follow the instructions by referring to Fig. 1 and tracing all the plate circuits shown in this diagram. Begin with the 6A8G tube and trace each plate circuit back to the filament of the rectifier tube. When you have done this draw the plate circuits in simplified form, using the principles of Fig. 17. This will be good experience for you and will be a great aid in tracing other circuits.

Next, refer to the screen grid circuits of Fig. 11. These are more difficult to trace than the plate circuits. There are only three screen grids in the entire receiver. Figure 19 shows the high voltage supply connected to the screen grid circuits. Further analysis with an *equivalent*

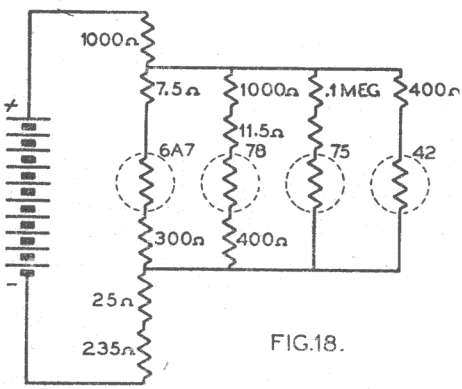


FIG.18.

pure resistance circuit (Fig. 20) shows a resistance network which is electrically equal to the screen grid circuit of Fig. 11. Compare Fig. 20 with the actual circuit, as shown in Fig. 11. See if you can trace the actual screen grid circuits in Fig. 11 and make them agree with the equivalent in Figs. 19 or 20.

When you have done this trace and draw the screen grid circuits in Fig. 1. The 6A8G, 6K7 and 6K6G tubes in this figure all have screen grids and are labeled SG at the tube socket symbols. Draw the equivalent circuit from the center tap on the high voltage winding of the power transformer all the way through the voltage divider, cathode, screen grids and back to the filament of the rectifier tube. Your circuit should then appear somewhat as in Fig. 19, with variations to fit the conditions of Fig. 1. Such a procedure is the best possible way to become an expert with radio diagrams.

In Fig. 21 the control grid circuits of Fig. 11 have been isolated from the balance of the circuit for individual study. The coils may be identified in the complete circuit of Fig. 11 by their resistance values. Since the control grids are not supplied with high voltage from the power unit, they cannot be shown connected to it. Nevertheless, *all of the other circuits* would be *inactive* without the grids, as you will learn later on when you get to studying tubes. The control grids may be thought of as the *nerve system* of the receiver. These grids receive the energy of the A.C. signal and make the proper variations in all the other circuits.

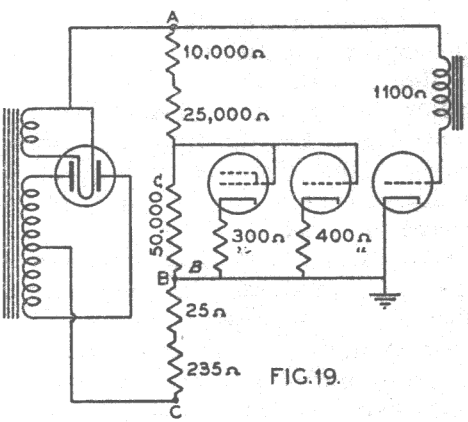


FIG.19.

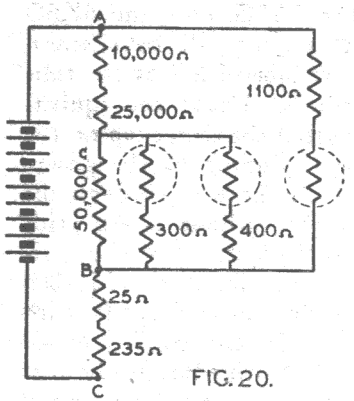


FIG. 20.

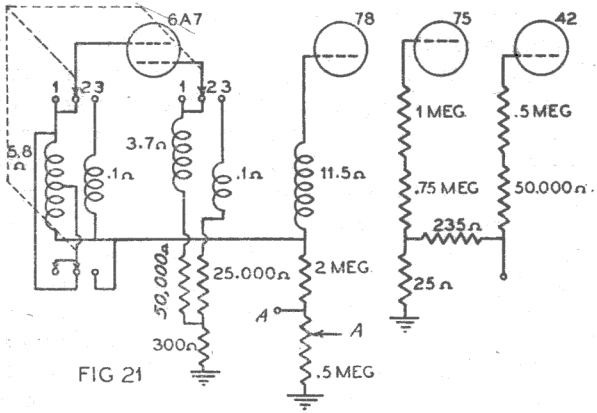


FIG 21

The complete switching system for the receiver in Fig. 11 can not be described at this point, but it would be well to note that all coil switches move together, and that those in the various control grid circuits of Fig. 11 only are shown. When all movable elements of the switches are on contact No. 1, the top cap (control grid) of the 6A7 (see Fig. 22) is connected through the entire 5.8 ohm coil, through the 2 meg. resistor, and through the .5 meg. (500,000 ohms) manual volume control to ground. The lower grid of the 6A7 (oscillator control grid—Fig. 22) nearest the cathode is connected through the 3.7 ohm coil, the 50,000 ohm and 300 ohm resistors to ground.

For position 2 of all the switches, the upper portion of the 5.8 ohm coil is shorted and only the lower part below the tap is used. The oscillator control grid has the same circuit as before. Note that contact 2 of the oscillator control grid switch is connected to contact 1.

For position 3 of all the switches, the 5.8 ohm coil is completely shorted (see lower position of switch) and the .1 ohm coils are used in both control grid circuits. Note this time, however, that 25,000 ohms is used in the oscillator control grid circuit instead of 50,000 ohms when the switch is in position 1 or 2.

The grid of the 78 tube is continuously connected through the 11.5 ohm coil, as shown, because there is no switch in its circuit. It should be clear that the switching arrangement in this and in similar circuits is for the purpose of tuning the receiver over different frequency bands—a subject which you will take up later.

This brings up the most interesting part of circuit analysis—that of tracing the path of the signal through the entire receiver. You cannot follow the signal (as you can the electron) throughout its entire path, since the signal changes from electricity to magnetism, to current flow, to electrostatic energy, direct current, etc. The signal goes through wires, tubes, air, iron, waxed paper, mica

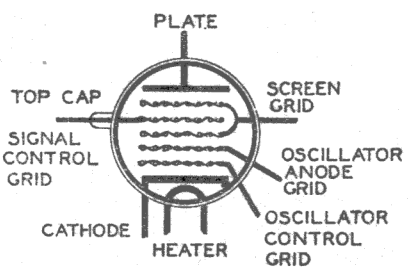


FIG.22.

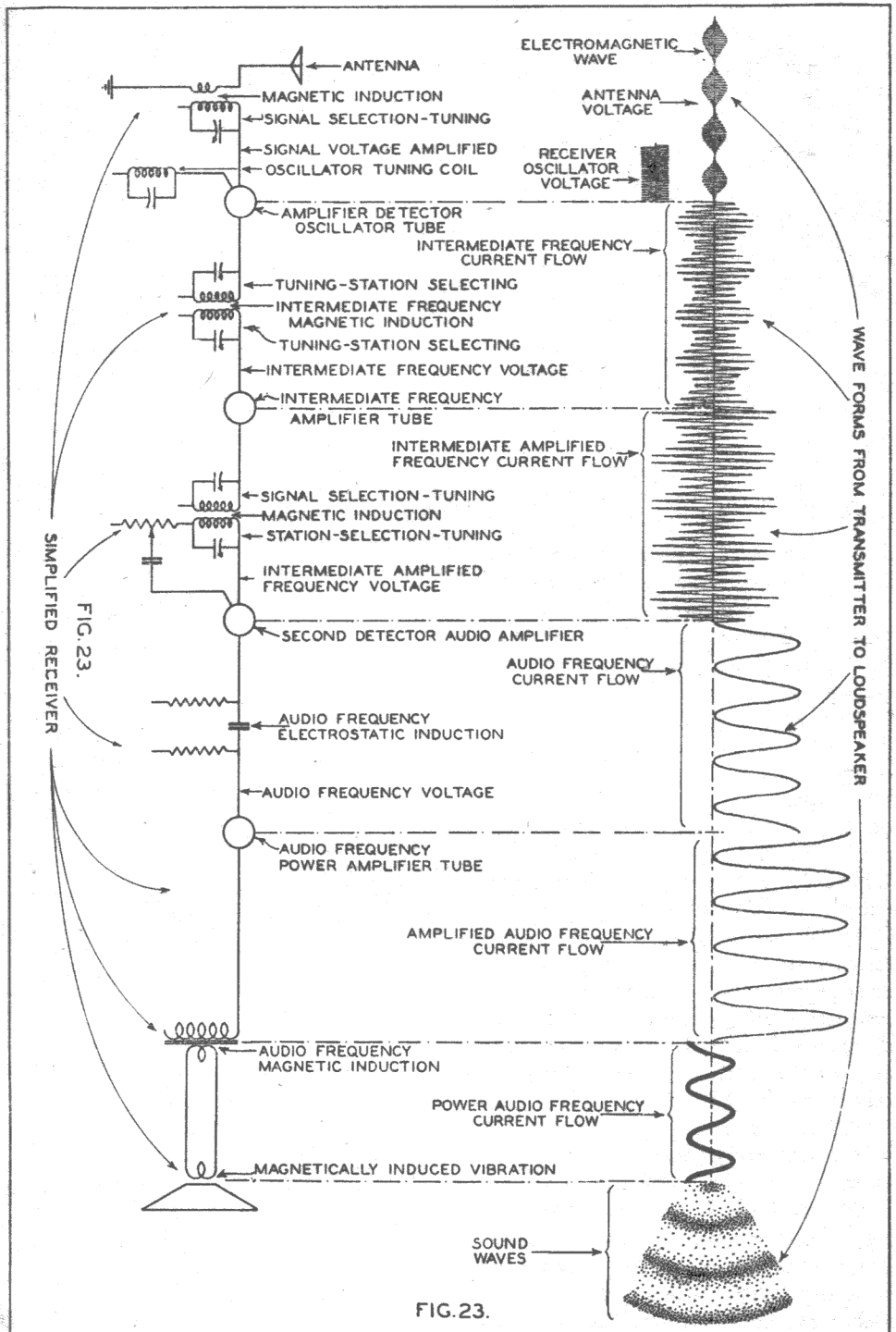

ELECTROMAGNETIC WAVE
ANTENNA
ANTENNA VOLTAGE
MAGNETIC INDUCTION
SIGNAL SELECTION-TUNING
SIGNAL VOLTAGE AMPLIFIED
OSCILLATOR TUNING COIL
RECEIVER OSCILLATOR VOLTAGE
AMPLIFIER DETECTOR OSCILLATOR TUBE
INTERMEDIATE FREQUENCY CURRENT FLOW
TUNING-STATION SELECTING
INTERMEDIATE FREQUENCY MAGNETIC INDUCTION
TUNING-STATION SELECTING
INTERMEDIATE FREQUENCY VOLTAGE
INTERMEDIATE FREQUENCY AMPLIFIER TUBE
INTERMEDIATE AMPLIFIED FREQUENCY CURRENT FLOW
SIGNAL SELECTION-TUNING
MAGNETIC INDUCTION
STATION-SELECTION-TUNING
INTERMEDIATE AMPLIFIED FREQUENCY VOLTAGE
SECOND DETECTOR AUDIO AMPLIFIER
AUDIO FREQUENCY CURRENT FLOW
AUDIO FREQUENCY ELECTROSTATIC INDUCTION
AUDIO FREQUENCY VOLTAGE
AUDIO FREQUENCY POWER AMPLIFIER TUBE
AMPLIFIED AUDIO FREQUENCY CURRENT FLOW
AUDIO FREQUENCY MAGNETIC INDUCTION
POWER AUDIO FREQUENCY CURRENT FLOW
MAGNETICALLY INDUCED VIBRATION
SOUND WAVES
SIMPLIFIED RECEIVER
WAVE FORMS FROM TRANSMITTER TO LOUDSPEAKER

FIG. 23.

FIG. 23.

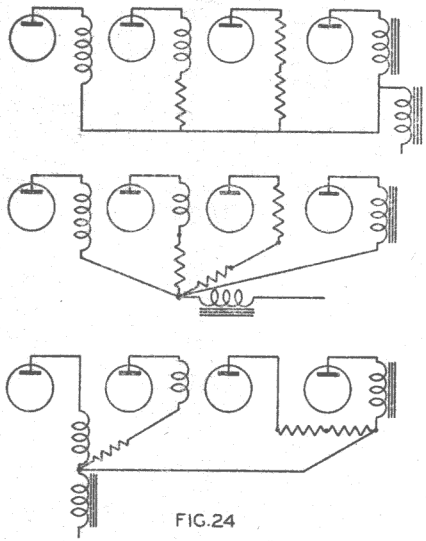


FIG.24

and metal in its path through the circuit; and there are no lines to show how this takes place. However, a graphic method of conveying this information is shown in Fig. 23, clarifying the principles involved.

In Fig. 23 a diagram of the signal is shown, along with the forms of energy into which it is converted in the various parts of the set, the names of the apparatus, the stages in the receiver and the actual circuit parts which carry the signal. This figure should be studied slowly and carefully. It is mainly given as a reference source so that you can refer back to it as you take up the study of other lessons in which these things will be described in detail. This completes all of the basic circuits of the receiver in Fig. 11.

All other parts in the receiver which did not appear in the separate circuits have a definite purpose. They are largely used to confine the signals to the proper paths, to prevent one part of the signal circuit from interfering with other parts. They also serve to make the various vital units operate properly.

Although you may know each symbol individually, the reason for its connection may not be entirely clear at this time. Only the purpose of the various circuits has been outlined. It must be remembered that each part is a story in itself.

A schematic circuit diagram is for the purpose of showing the electrical association of the various parts. The exact connections within the receiver are somewhat different mechanically, because of the arrangement of parts, and often the shortest possible connection may be used. Thus, for example, in Fig. 24 the schematic diagram may show the connections as at the upper figure, but the actual parts may be connected to a common terminal as at the center. Or the connection may actually be as shown in the lower figure, *although all three circuits are electrically the same.* This is because a wiring diagram simply shows which terminals are *connected into groups. The important thing is that although the physical wiring may differ from the way the diagram shows it, actually the circuit will be found to correspond electrically to the diagram.*

The power supply circuit may actually be wired as in Fig. 25 rather than as the diagram in Fig. 11 shows. Again, both of these are electrically the same.

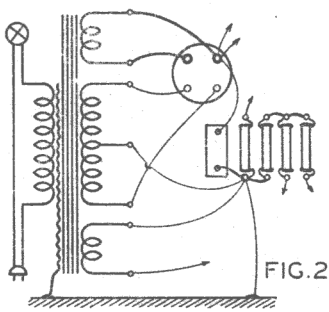


FIG.25.

The questions included below should not be answered by you. They are included in this book to give you an idea of the type of questions employed in our lessons. Should you desire to enroll for our radio training you will be given grading service, consultation service and all the other services and privileges as mentioned in our catalog.

ENROLL NOW WITH THE SPRAYBERRY ACADEMY

Questions

No. 1 What information about condensers do you get from the symbols in Fig. 3?

No. 2 How many fixed resistors are shown in Fig. 21?

No. 3 Will the number of loops in a coil symbol indicate how many turns the coil has; and what is the difference between C and K in Fig. 4?

No. 4 What type of tube is indicated in Fig. 7?

No. 5 Referring to Fig. 14, which symbol indicates a wire connection and which one indicates no connection?

No. 6 How may filament circuits be indicated as being connected without showing the actual wires?

No. 7 What does Fig. 18 represent?

No. 8 In Fig. 11 are there any control grids which cannot be traced to ground through coils or resistors or combinations of these?

No. 9 Does a circuit diagram show exact electrical connections within a receiver, or simply the equivalent electrical connections?

No. 10 Name three different kinds of energy into which the signal is changed in passing through a complete radio circuit.